

French Family Housing Sector: Energy, Behaviours and Markets

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This paper aims to present the most important results obtained from six years experience on surveys concerning opinions, behaviours and attitudes of the French families about energy problems. Ten thousand families have been asked every year about their way of using energy systems, their energy expenses and the retrofitting works they have performed on their houses: insulation (walls, roof, double-glazing...) or heating systems (generators, domestic hot water systems (DHW), controls...). These annual surveys show statistically representative results concerning energy retrofitting markets in the old stock of French houses and energy equipment markets in the new buildings. They give an evaluation of the energy efficiency investment market in the housing sector. Additionally, equipment rates of the French housing stock for roof, walls or floor insulations, double-glazing and high efficiency heaters are shown. Complemented by other energy consumption surveys, this equipment rate picture allows an estimation of the average French house's efficiency level, indicates that a large number of energy conservation actions have been already realized, nevertheless wide potentials in energy conservation still remain.

Introduction

Each year since 1985, a French sounding Institute (SOFRES), has achieved within the framè of an Ademe contract, a general mail survey addressed to ten thousand French families calculated to reflect the total French population. The aim of this survey is to identify the family behaviours in the field of domestic energy uses in their houses, and to put forward evolutions that should influence energy policy decisions.

Each annual survey is composed of two separate phases:

- The first phase consists of a mail survey including a large set of questions on energy equipments, both heating and domestic hot water systems and insulation levels of roofs, walls and floors. This information gives the knowledge on the kind of retrofitting works achieved in the French houses during the last 15 years, furthermore it is a good tool to evaluate the average energy efficiency increase of the total stock. Questions include some specific items on heating temperature rates, or satisfaction index about space heating. Finally, some identification questions are used to sort answers on energy or socio-demographic types.
- The second phase is a new mail survey only addressed to the families declaring in the first phase questionnaire that they achieved some energy retrofitting works during the last year. These families receive a new set of questions especially concerning these retro-

fits: nature of intervention, costs, fitter and family satisfaction index... This general two-phased survey is the only tool used by Ademe to obtain information about family implication levels in the field of energy in the French main residences. The survey also shows the energy efficiency business and gives back information about energy policy launched either by the government or the energy utilities.

French Housing Sector: Key Numbers

In June 1990, the French housing stock amounted to 26.3 million houses, including 2 million vacant houses and 2.6 million vacation homes. Main residences (21.7 millions) were composed with 55% of single family houses (individual) and 45% of flats in multi-family buildings. 75% of these houses have been built before 1975, year of the first French regulation on energy efficiency new houses, so that they have not integrated any insulation, at least when they have been built.

The total energy consumption of the French stock of main residences is 385 TWh, wood consumptions not included. Fuel gas is the main energy consumed (32%), followed by fuel oils (30%) and electricity (27%). Heating is the principal end use with 73% of the final consumption¹. Domestic hot water production comes after (11%), then electric appliances and lighting (10%) and cooking (6%).

Table 1. French Housing Stock (Main residences - 1990 - CEREN)

<u>Thousand of houses</u>	<u>Single-family (individuals)</u>	<u>Multi-family (flats)</u>
Collective central heating	--	4,778.5
Individual central heating	9,504.8	3,489.7
Fuels heating	6,365.5	2,115.5
Electric heating	3,139.3	1,374.2
Others (no central heating)	2,474.7	1,414.3

Family Survey Main Results

About Behaviours

The first observation is that the French family behaviours have, taken as a whole, marginally moved since 1985, despite the decreasing of energy prices.

Generally speaking, families save energy as long as it does not correspond to too many sacrifices. Most of the families (72%) use heating system thermal controls, according to how they occupy the house, reducing and even also switching off the generators while they are not at home. Also 80% declare that they take care to avoid wasting energy while using it. But on the contrary, very few of them (23%) would decrease the temperature level in the house even though they could dress themselves more warmly. Most of the families (75%) have declared a

heating temperature between 18°C and 20°C (64.4°F and 68°F). But some of them (25%) would prefer to heat over 20°C to feel more comfortable. It is characteristic that the heating temperature differs perceptibly according to the kind of rooms and the periods of the day. More than 40% of the families reduce the living rooms temperature at night, and even stop heating while sleeping.

The temperature level also appears correlated to the kind of house and heating system. It is lower than the average temperature in individual housing especially heated with central heating systems using fuel oil or electricity, which are the most expensive heating fuels in France. On the contrary, the temperature level is higher than the average in multi-families blocks of flats with collective central heating which have low levels of controls available for the user in this kind of house and system.

Table 2. Temperature Declarations

<u>% of households</u>	<u>During the day</u>	<u>At night</u>
Living rooms		
less than 18°C	11%	41%
from 18°C to 20°C	73%	52%
more than 20°C	16%	7%
Bedrooms		
less than 18°C	46%	57%
from 18°C to 20°C	49%	39%
more than 20°C	5%	4%

(18°C=64.4°F; 20°C=68°F)

Satisfaction Level About Heating Systems

Heating is the most important part of energy consumption and expenditures in French main residences as this end use represents 73% of the total consumption. In a general way, most of the families (87%) are largely satisfied with their heating system. Most of them are also satisfied with the safety and low level of environmental impacts of their boilers (92%). They also declare themselves to be largely satisfied on comfort and commodity of use conditions (86%). On the contrary they are less satisfied concerning the expenditures for heating (69%).

Gulf Oil Crisis

A particular question was carried out in the beginning of 1991, just after the end of the Gulf Oil crisis (Kuwait/Iraq war) and upon this event, concerning evolution of the family behaviours about energy.

In fact, the war affected very few modifications of energy behaviours:

- 28% of the families were not anxious at all and thought that no problem would really occur,
- 53% were, at least, a little more anxious but didn't modify their behaviours,

- only 10% of the families declared that they had managed their energy budgets more carefully.

It is interesting then, to notice that there seems to be no more effect of oil shocks as we could see in 1973 and 1979 during such events.

Annual Energy Expenditures

This information is only available since the 1989 survey. Analyses are issued from mail answers, only in case of families declaring that they have read information on their bills. The annual family expenditure average has reached a 6,500 FF amount per house (1,200 US \$²) in 1990. It amounted to 6,200 FF in 1989 (1,150 US \$) and reached 7,300 FF (1,350 US \$) in 1991 due, at least in a large part, to a heating degrees-days (HDD) increase. On an 8,700 families sample, the annual energy expenditure appears as a very dispersed value showing, of course, a large diversity of cases either on family structure or on house needs.

The annual average expenditure is widely changing according to the criteria mentioned below:

The kind of houses and heating systems

Energy is much more expensive in individual houses than in flats, especially when the houses are centrally heated.

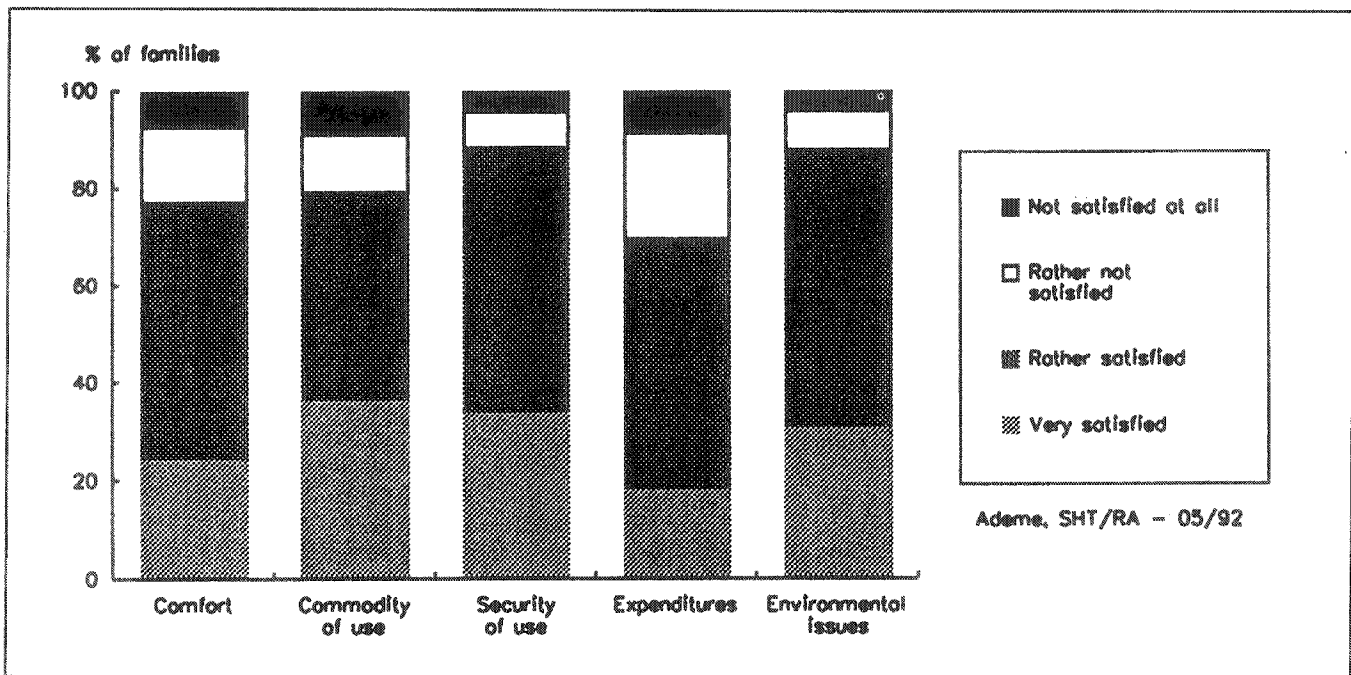


Figure 1. French Family Satisfaction Index on Space Heating Systems

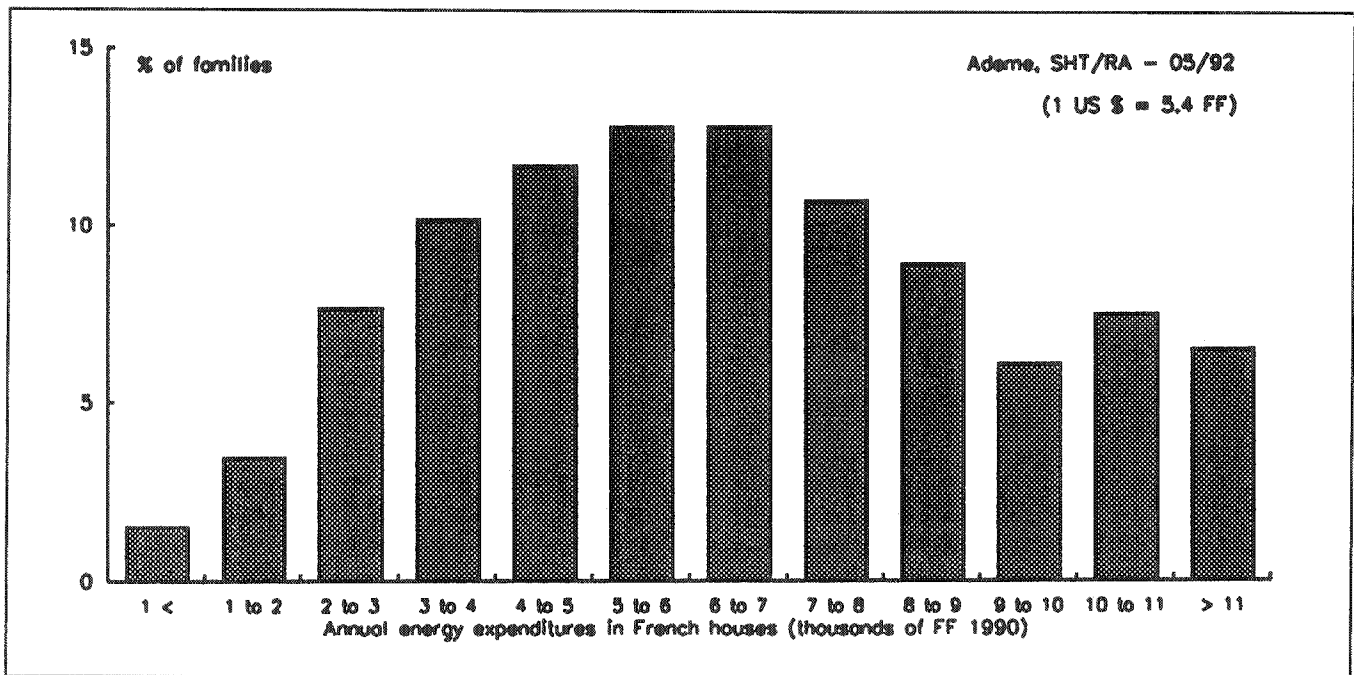


Figure 2. Housing Sector Annual Energy Expenditure Dispersions

This difference is quite normal according to the lodging areas that are generally larger in the case of individual houses (average area = 100 m²), than in the case of flats (average area = 70 m²).

The climatic conditions

Three climatic zones have been defined for France to give a global picture of climatic deviations:

- H3 = South France (normal HDD = 1,540 °C)
- H2 = Ocean Coast (normal HDD = 2,170 °C)
- H1 = North France-Continental (normal HDD = 2,630 °C)

Of course, energy expenditures are largely a function of these climatic differences, but not in such a way as could have been expected while looking at climatic deviations.

Socio-demographic criteria such as money income or age of the head of family

Energy expenditures are proportional to the money income of the families and of course, the families earning more money have a higher expenditure according to their usually higher life style.

Expenditures also show large variations according to the age of the head of family, with an increasing trend up to 55 years old, while building the social situation of the

family, then a decreasing trend with family needs related to old age.

An inference from this point is that energy expenditures are not only related to energy efficiency of houses but also largely a function of social characteristics of the families, on which energy policies have small impacts. This fact shows that energy consumption should increase both as a result of economic growth income for the under-privileged families and as a result of the social demand of the whole population for better life styles.

Equipment Rates of Insulation and Energy Efficiency Systems

Asking families about insulation equipments and energy efficiency systems in their house shows a picture of the average energy efficiency quality of the stock of the French main residences.

Insulation

Through the only sample of answers, the survey shows that owners have performed more insulation retrofitting works than rental families.

Roof insulation presents the higher equipment rate with a 63.6% average (73.2 for owners and 40.6 for rental). Wall insulation and double-glazing are less disseminated

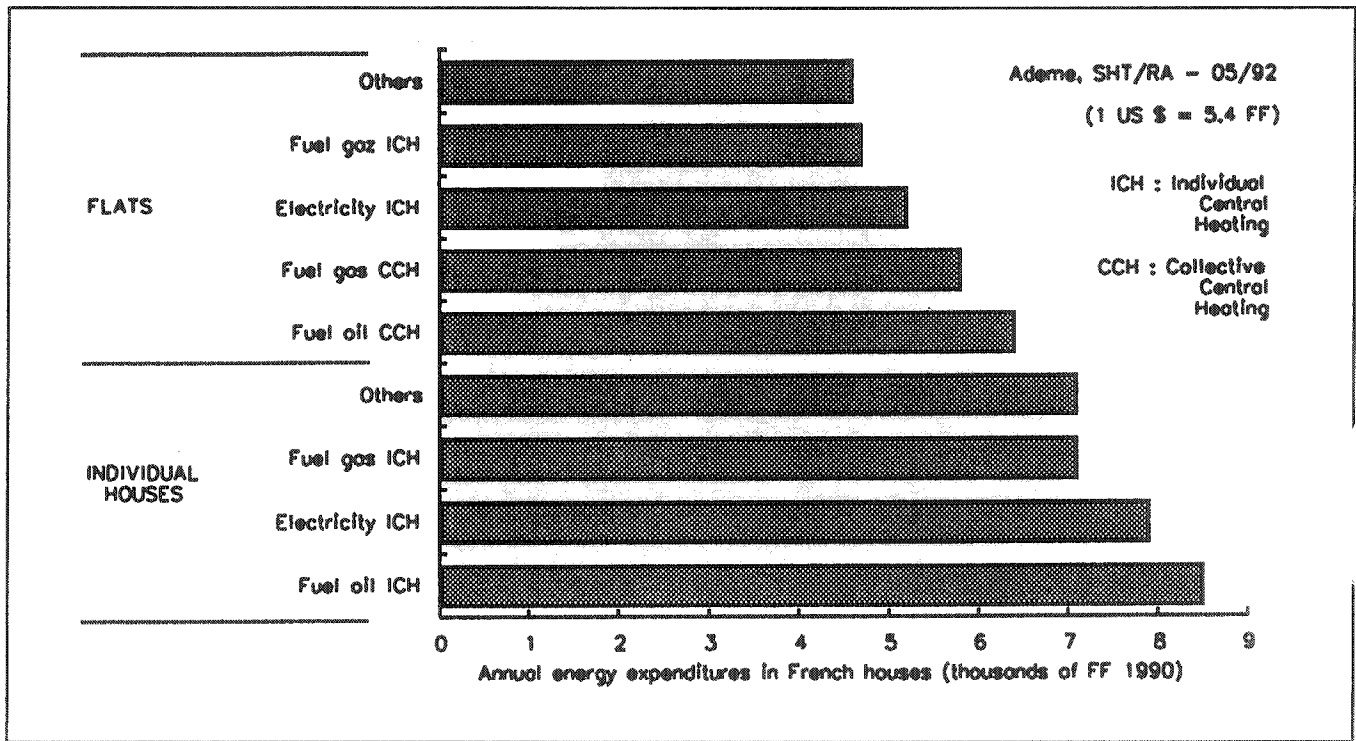


Figure 3. Average Annual Energy Expenditures According to House and Heating System Types

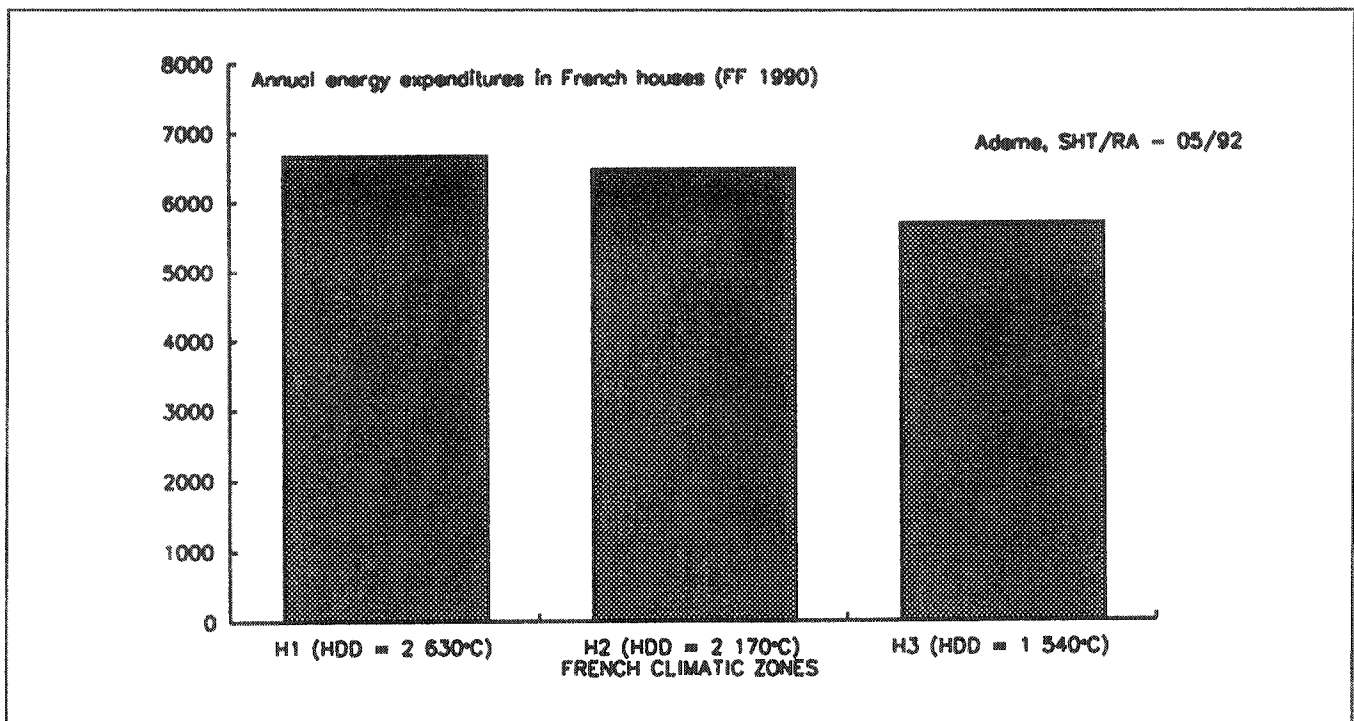


Figure 4. Average Annual Energy Expenditures According to Climatic Conditions

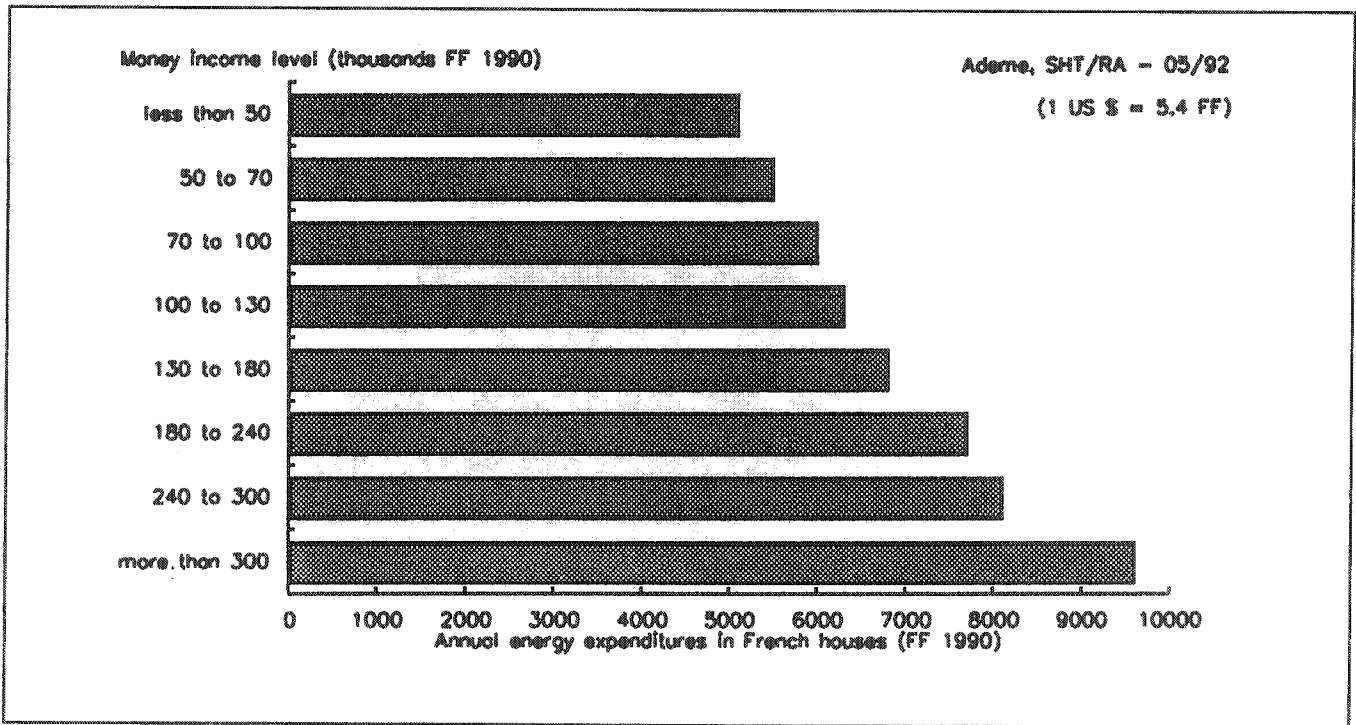


Figure 5. Average Annual Energy Expenditures According to Money Income

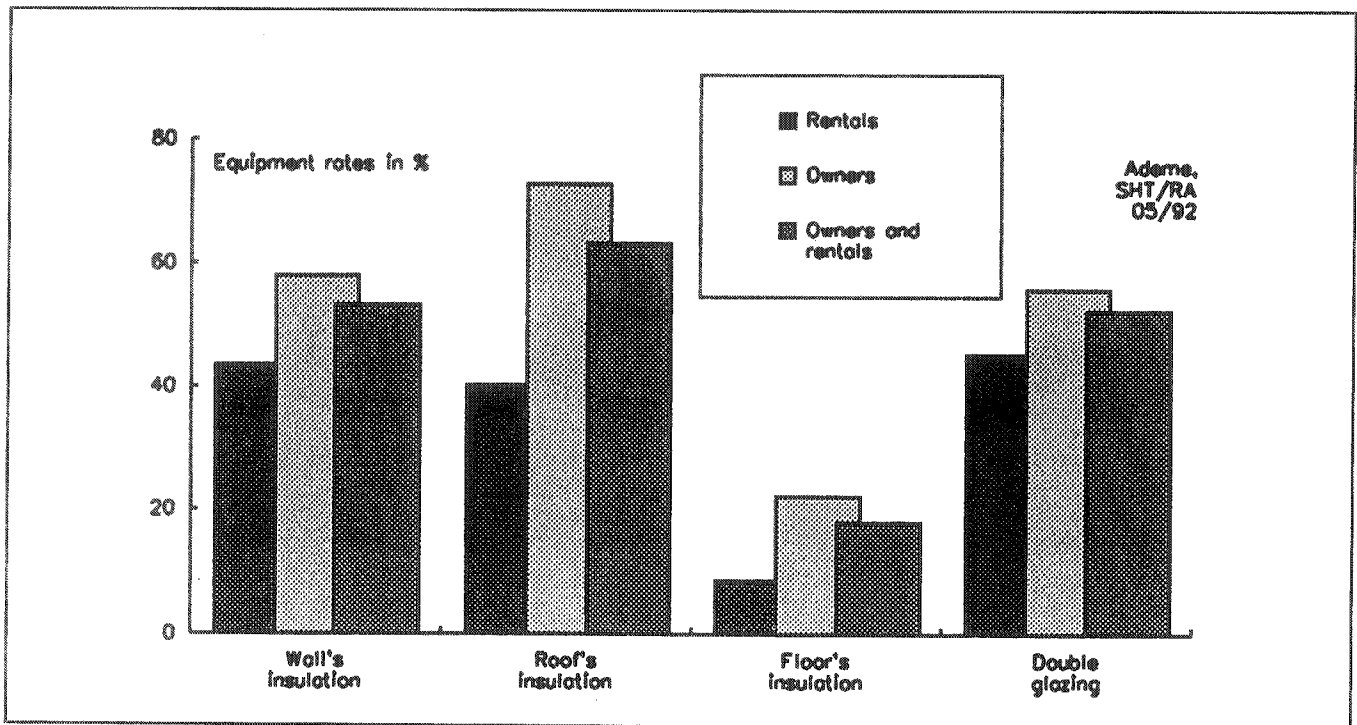


Figure 6. Insulation Equipment Rates in the French Housing Sector

with respectively only a 53.6% and 52.7% average but nevertheless reach quite high values. On the contrary, floor insulation has been disseminated at a low level with only an 18.4% equipment rate.

Heating systems

As far as individual central heating systems are concerned (8.5 million main residences i.e., 40% of total housing stock) one can observe that very few families are equipped with high efficiency boilers. 89.6% of them still have standard efficiency boilers. Age of the boiler was asked the families: in 1990, more than 35% of the total individual boiler stock is older than 15 years, and then presents a lower efficiency than new generation boilers (10 to 30% better efficiency).

On the other hand, control systems such as ambient air temperature thermostatic controls or thermostatic faucets are quite widely used as respectively 57.5% and 44.8% of the heating systems are equipped with such components. On the contrary, programming clocks are still slightly used (16.4%).

Using the large information available, the whole data have been analyzed on a hierarchical system based on energy efficiency equipment rates. It shows that, still in 1990, 46% of the French main residences have very little efficient insulation, only 40% have a high efficiency heating system and just 14% are equipped with both efficient insulation and heating system.

Energy Retrofitting Works

Reducing energy expenditures is the main motivation of the families to engage retrofitting works in their house. It

is declared in 40% of the cases while 33% of them declare their motivation to perform works as better comfort. Ten percent of the total French families have declared that they have performed in 1990 in their house, at least one energy retrofitting work appointed on the following list:

- roof, wall, floor insulation
- double-glazing, weather-stripping
- boiler
- ambient air temperature control, thermostatic faucets
- programming clock.

The French stock of houses is 21.6 million in 1990, so that about 2.2 million main residences have been, even to a small degree, improved with retrofitting works. Since 1985, between 2 and 3 million main residences have been improved every year in the same way.

The most important part of these works are performed on the building (71%), for insulation on walls (18%), roof (12%) or floor (3%) and windows improvement as double glazing (17%) or weather-stripping (21%). 18% of the works occur on changing boilers, burners or changing energy for space heating. Controls and programming clocks reach only a 5% part of the market.

The average expenditure is around 11,900 FF (2,200 US \$) per family for an average cost of 8,500 FF (1,570 US \$) per work. Of course, costs are largely dispersed, with a higher average cost for works concerning the space heating systems (11,600 FF i.e., 2,150 US \$) than for works concerning building insulation (7,300 FF i.e., 1,350 US \$).

Table 3. Individual Boilers - Installation Dates

Installation Date % of Boilers	Periods of Surveys		
	1988	1989	1990
Before 1971	19.2	17.1	18.5
From 1971 to 1975	18.5	17.2	16.9
From 1976 to 1980	20.5	20.2	18.6
From 1981 to 1985	24.4	22.6	19.9
Less than 1985	17.4	22.9	26.1
Total Stock (millions)	8.1	8.3	8.5

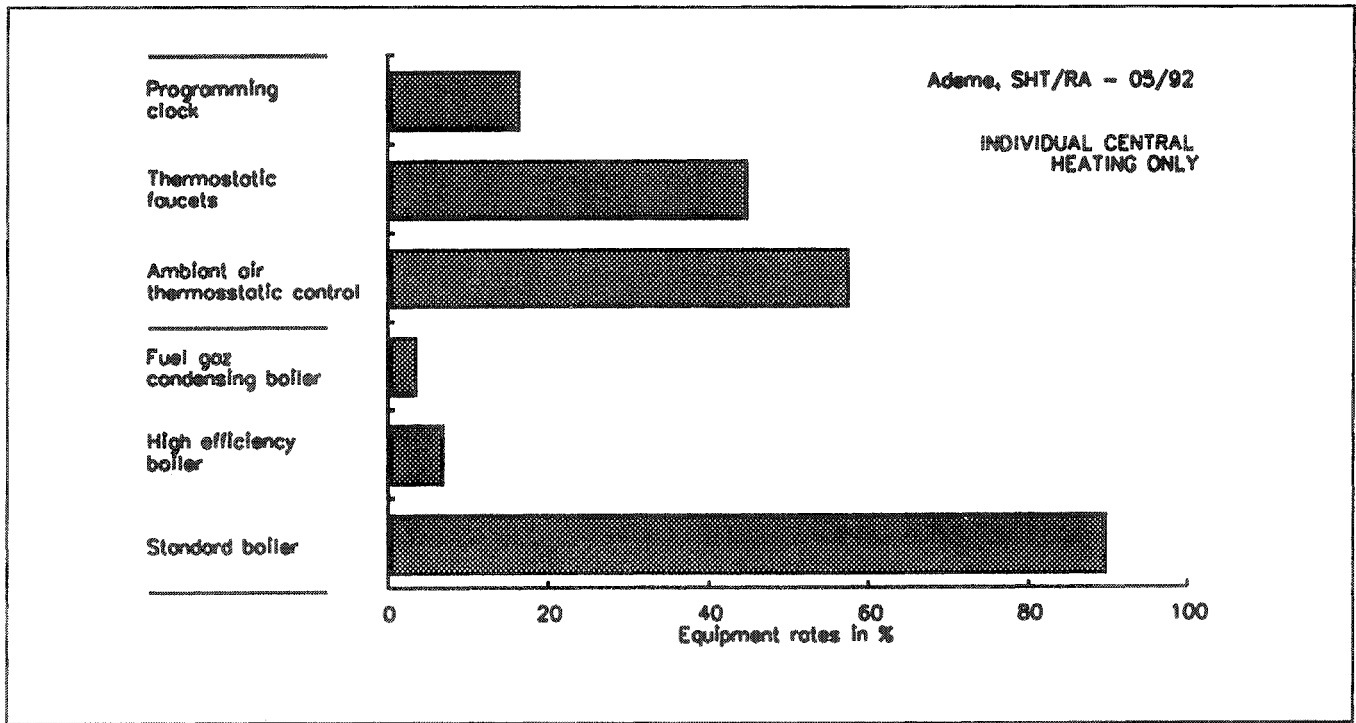


Figure 7. Energy Efficiency Systems Equipment Rates in Individual Central Heating

Table 4. French Housing Stock Average Quality - Houses in % per Quality (sample - 9,458 houses)

Low Efficiency Insulation		High Efficiency Insulation	
Quality A	Quality B	Quality C	Quality D
No efficiency equipment at all or roof insulation only or walls insulation only or roof insulation and double-glazing only or walls insulation and double-glazing only	High efficiency boiler alone or with roof insulation only or with walls insulation only or with roof insulation and double-glazing only or with walls insulation and double-glazing only	At least: roof and walls insulation or roof and walls insulation and double-glazing	High efficiency boiler and roof and walls insulation or high efficiency boiler and roof and walls insulation and double-glazing
46%	28%	14%	12%
Low Efficiency Heating system	High Efficiency Heating system		

Table 5. Retrofitting Work Annual Rates

<u>Retrofitting Works Annual Rates</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991*</u>
% of Households	14.1	13.2	9.2	10.9	10.2	10.2
Millions of Households	2.9	2.7	1.9	2.3	2.2	2.2

* Provisional

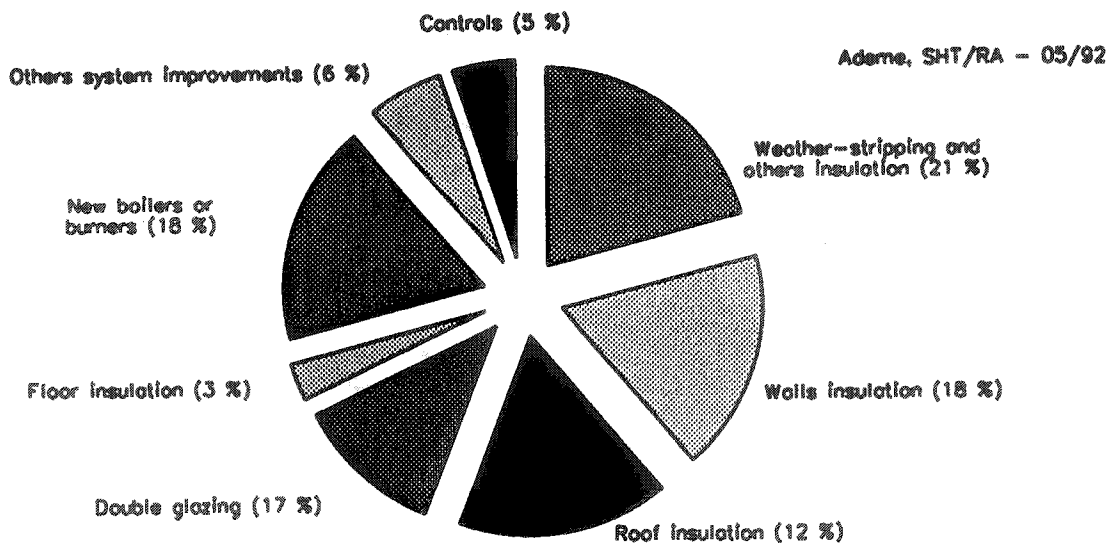


Figure 8. Energy Retrofitting Works Realized in 1990

The global investment undertaken by all families having performed some energy retrofitting works in their house can be estimated around 24 billions of FF (4.5 billions of US \$), that is a little bit more than 8.5% of the total GDP of the retrofit works in the French building sector (296 billions of FF tax included). Half of the works are undertaken by families themselves, the other half being performed by craftsmen, especially on heating systems (changing boilers and burners, installing controls) which need more technical ability and building insurances. Asking about the quality of insulation works, it seems that families are used to insulate a quite important part of the building while 40% of them put this material on more than 50m²/area.

Conclusion

Annual surveys launched to families show very interesting results about behaviours and retrofitting works and give much information to evaluate the global population implication in energy efficiency policies. On longer periods, trends must be developed to secure both information and analysis. Ademe already has 6 years of experience on this matter. Nevertheless, some of the above mentioned results have to be taken into account with care, especially because of the technical matter of many questions, which might be, in some case, misunderstood by the families. Nevertheless, the high level of expenditures by the families shows that housing retrofit, including energy retrofitting works, is a real social benefit, with outlets to

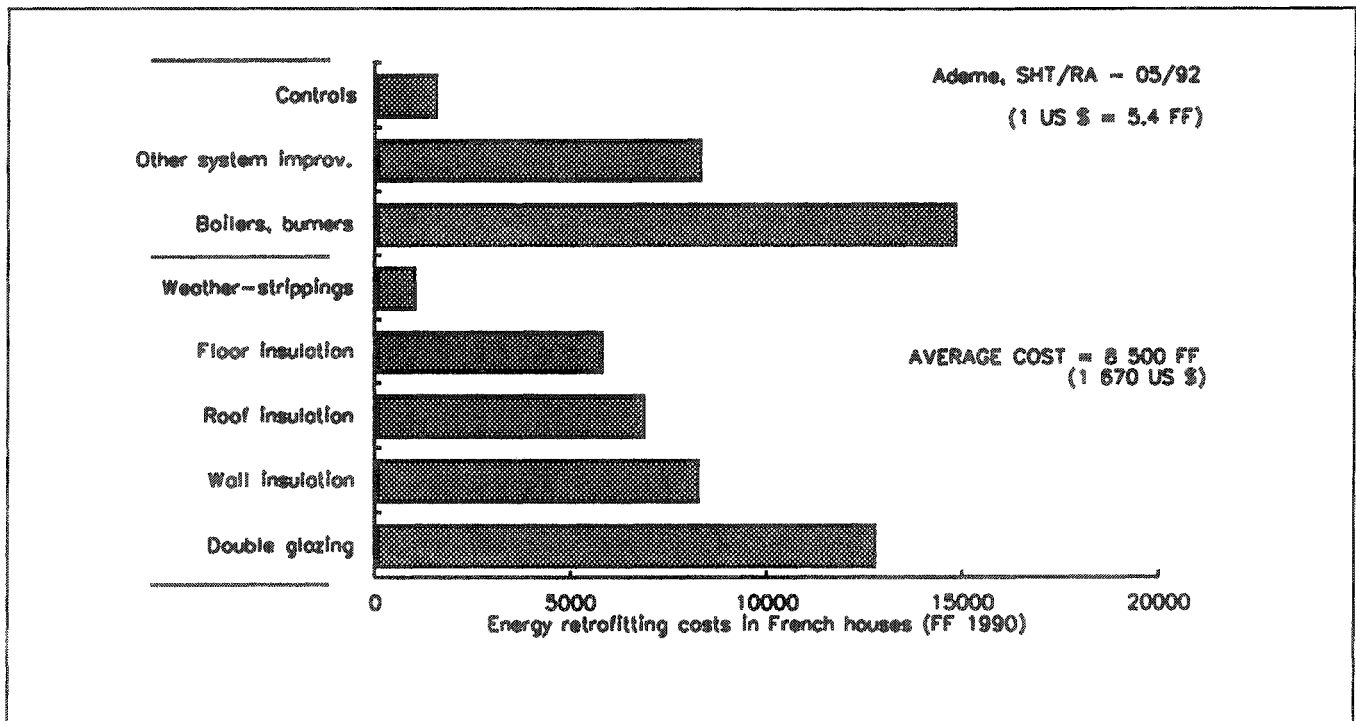


Figure 9. Average Costs of Energy Retrofitting Works

more comfort and a better quality way of life also in relation to the reduction of environment issues and harmful effects. In terms of energy efficiency, annual flows of retrofitting works show that many good results have been observed. Space heating average consumption has been restricted even with a best comfort increase in the other side. The long period observation and analysis of the space heating unitary consumption of the French housing stock shows large reductions of house heating needs:

- in old buildings, built before the first step of thermal regulation that occurred in 1975, a 43% average reduction in individual houses and a 28% average reduction in flats can be observed,
- in recent buildings, built since 1976 under a three steps thermal regulation, here again a 44% reduction in houses and a 34% reduction in flats heating consumption has been obtained. These results are obtained from specific surveys in French representative houses³. These surveys contribute to building the French statistical system on housing stock and energy consumptions.

On the other hand, equipment rates are yet quite low for many of them. This shows a rather important true bearing for energy efficiency forecasts to be reached through new energy conservation policies.

Endnotes

1. Very few French houses are climatized.
2. 1 US \$ = 5,4 FF
3. Source: CEREN - Research and Economical Study Center on Energy - FRANCE.

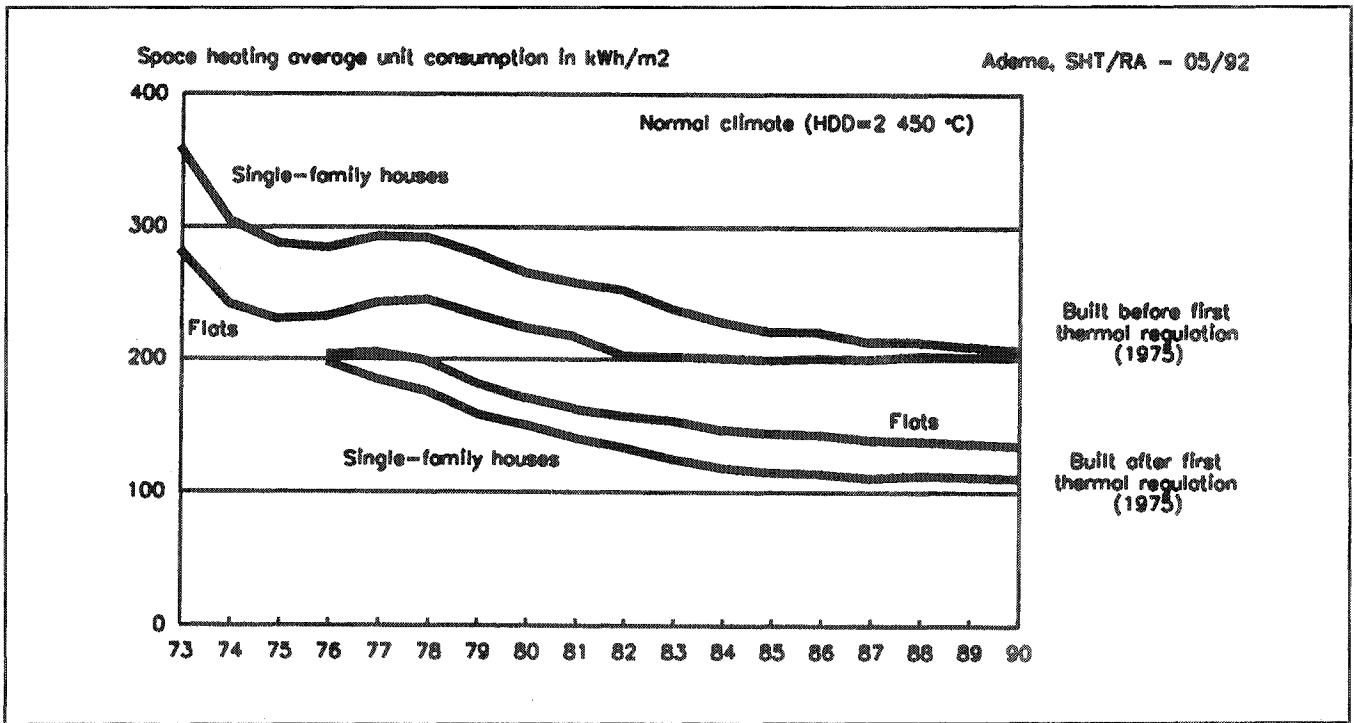


Figure 10. Space Heating Unitary Consumption Evolution in the French Housing Sector